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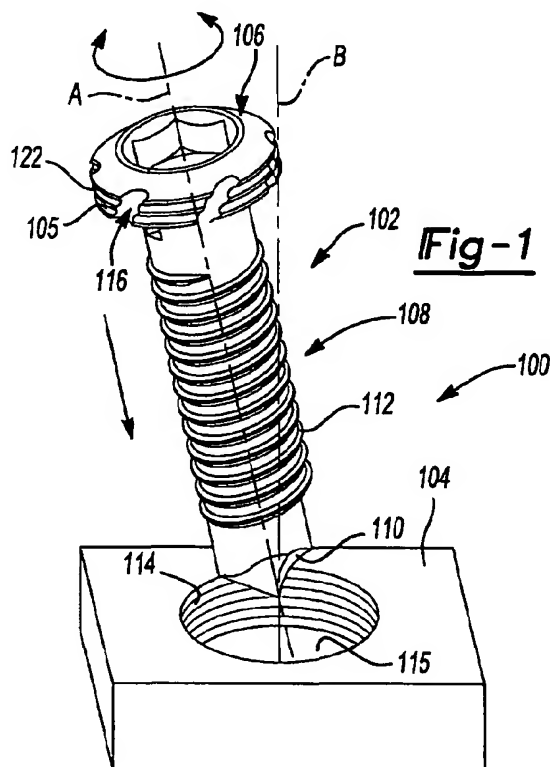
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(54) **Variable angled bone fixation assembly**

(57) A bone fixation assembly and associated method. The bone fixation assembly includes a bone fastener having a shaft for engaging a bone, and a head connected to the shaft. The shaft defines a longitudinal first axis. The bone fastener also includes a plurality of external thread windings defining an outer surface of the head. The external thread windings are circumferentially interrupted by at least one slot defined on the outer surface. The slot is inclined at an angle relative to the first axis.



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Description

[0001] In certain orthopedic surgical procedures, it is necessary to secure multiple bones or bone portions relative to each other. For example, in spinal surgeries, the fusion of two or more vertebral bodies is required to secure a portion of the spinal column in a desired position. Portions of other bones of the human body can be similarly joined. This need may be the result of physical trauma from fractures or dislocations, degenerative diseases, or tumors.

[0002] Various plating systems for internal fixation of various bones are known. Such systems generally include a plate that is attached to the bone or bone portions spanning a fracture line or a spinal disc space. The plate typically includes a plurality of holes through which bone screws are inserted for engaging the bone.

[0003] Some plating systems include constrained or locking screws, which are adapted for locking in corresponding plate holes in a fixed orientation. Other plating systems include semi-constrained or non-locking screws, which can be configured to maintain a variable orientation relative to the plate. Examples of plating systems that include constrained and semi-constrained screws are disclosed in currently pending, co-owned U.S. Patent applications Serial No. 11/023096, filed December 22, 2004, and Serial No. 11/124535, filed May 5, 2005. The disclosures of these applications are incorporated herein by reference. A plating system that includes a locking ring that prevents the screw from backing out of the plate is disclosed in commonly owned U.S. Patent No. 6,599,290, the disclosure of which is incorporated herein by reference.

[0004] Although the existing plating systems can be satisfactory for their intended purposes, there is still a need for new plating systems that are effective and efficient and also provide operative simplicity and versatility to the surgeon.

SUMMARY

[0005] The present teachings provide a bone fixation assembly that includes a bone fastener. The bone fastener includes a shaft for engaging a bone and a head connected to the shaft. The shaft defines a longitudinal first axis. The bone fastener also includes a plurality of external thread windings defining an outer surface of the head. The external thread windings are circumferentially interrupted by at least one slot defined on the outer surface. The slot is inclined at an angle relative to the first axis.

[0006] The present teachings also provide a bone fixation assembly that includes a fixation member having a threaded aperture, and a bone fastener having a head and an anchoring portion. The head includes circumferentially interrupted external threads such that the head can engage the aperture at an angle by controlled angled-threading.

[0007] The present teachings also provide a method for securing a bone fastener to a bone fixation member. The method includes providing a bone fastener defining a first axis, the bone fastener having a bone anchoring portion and a head having an external thread thereon, providing a bone fixation member defining at least one aperture having an internal thread, the aperture defining a second axis, inserting the bone fastener through the aperture, and securing the head of the bone fastener to the aperture such that the first axis is inclined relative to the second axis.

[0008] Further areas of applicability of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0010] FIG. 1 is a perspective view of a bone fixation assembly according to the present teachings, shown before assembly;

[0011] FIG. 2 is a perspective view of a bone fastener of the bone fixation assembly of FIG. 1;

[0012] FIG. 3 is a top end view of the bone fastener of FIG. 2;

[0013] FIG. 4 is a top end perspective view of the bone fastener of FIG. 2;

[0014] FIG. 5 is a perspective view of the bone fixation assembly of FIG. 1, shown partially assembled;

[0015] FIG. 6 is a perspective view of the bone fixation assembly of FIG. 1, shown fully assembled; and

[0016] FIG. 7 is a sectional view of the bone fixation assembly of FIG. 1, shown fully assembled.

DESCRIPTION OF VARIOUS ASPECTS

[0017] The following description is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses. For example, the present teachings can be used for, but are not limited to, fusion procedures of adjoining bones, such as vertebrae, and/or for internal fixation of fractures in any bones.

[0018] Referring to FIG. 1, an exemplary bone fixation assembly 100 according to the present teachings is illustrated before assembly. The bone fixation assembly 100 can include a bone fastener 102 defining a longitudinal axis "A", and a fixation member 104. The fixation member 104 can be a planar body, such as a plate, or a curved generally two-dimensional body adapted to be positioned adjacent or against a bone surface for securing, stabilizing, or fusing a bone or bone portions to each other. The fixation member 104 can include one or more through-holes or apertures 115 having a center axis "B". Each

aperture 115 can include internal threads 114. The aperture 115 or at least the threaded portion thereof can be spherical.

[0019] Referring to FIGS. 1-4, the bone fastener 102 can include a head 106 and a bone anchoring portion 108, such as a shaft, terminating at a distal tip 110. The anchoring portion 108 can include a helical or other type of thread 112. The diameter of the head 106 can be larger than the diameter of the bone anchoring portion 108. The head 106 can include an engagement formation 130 for engaging a driver or other insertion tool (not shown) to the head 106 for inserting the bone fastener 102 into bone. The head 106 can have a convex curved lateral or outer surface 105, which can be, for example, spherical, and adapted for engagement with a similarly shaped portion of the aperture 115. The outer surface 105 can include a thread having external threads (thread windings) 122 that are circumferentially interrupted by one or more slots 116. Although six slots 116 are illustrated in FIG. 3, it will be appreciated that the number of slots 116 can vary. The slots 116 can be inclined/skewed relative to the thread windings 122 and relative to the longitudinal axis A of the bone fastener 102. For example, the slots 116 can be inclined at an angle relative to the longitudinal axis A ranging from zero (parallel to the longitudinal axis A) to about 70 degrees. The slots 116 can be shaped and oriented such that when the head 106 is threaded to the aperture 115, any soft tissue remaining on the fixation member 104 is removed and directed through the slots 116 away from aperture 115 and the bone fixation site. The slots 116 can define, for example, cutouts 120, and tissue-cutting or tissue-removing edges 118, as shown in FIG. 4, for clearing the aperture 115 of tissue. The slots 116 can also be shaped and oriented to guide the bone fastener 102 for variable angle fixation relative to the fixation member 104, as discussed below.

[0020] Referring to FIGS. 1 and 5-7, the bone fastener 102 can be inserted into the aperture 115 such that the axes A and B coincide, or such that the axes A and B define a variable angulation angle α , as desired by the surgeon. When the axes A and B are made to coincide, the external threads 122 of the head 106 can engage the internal threads 114 of the aperture 115 without angled-threading, i.e. with each single internal thread winding 114 engaging a single external thread winding 122 and conversely. When the axes A and B are positioned at an angle, the slots 116 provide a form of controlled and guided "angled-threading", such that a single internal thread winding 114 can engage portions of more than one external thread winding 122 at an angle, and conversely. For example, each slot 116 can be of a width and orientation such that when the bone fastener 102 is rotated at an angle relative to the axis B of the aperture 115, an internal thread winding 114 that becomes initially engaged with a particular external thread winding 122 encounters the slot 116 and disengages from that particular external thread winding 122. The shape (including size) and orientation of the slots 116 can be selected for con-

trolling and guiding the angled-threading such that there is no damage to the external or internal thread windings 122, 114. Such damage is sometimes associated with unintentional and undesirable cross-threading.

[0021] As illustrated in FIG. 1, the bone fastener 102 can be oriented at a desired angle relative to the fixation member 104 and inserted through the aperture 115 into bone. Referring to FIG. 5, rotating the fastener 102 with a driver or other insertion tool, gradually drives the anchoring portion 108 into the bone, while the edges 118 of the slots 116 remove any tissue from the aperture 115, and guide removed tissue along the slots 116 away from the aperture 115. After any such tissue is removed, the external threads 122 of the head 108 engage the internal threads 114 of the aperture 115 at an angle, as discussed above, securing and locking the bone fastener 102 at an angled position relative to the fixation member 104, as shown in FIGS. 6 and 7. Variable angle fixation and self-locking are, therefore, effected by the fastening mechanism that includes the circumferentially interrupted external threads 122 on the outer surface 105 of the head 106 of the bone fastener 102, without need of additional components or parts, thereby simplifying the surgical procedure.

[0022] As described above, the bone fixation assembly provides the surgeon with the option of anchoring the bone fastener 102 at a desired angle relative to the fixation member 104, while clearing tissue from the aperture 115 of the fixation member 104, thereby providing clean engagement surfaces for locking the bone fastener 102 to the fixation member 104.

[0023] The foregoing discussion discloses and describes merely exemplary arrangements of the present invention. One skilled in the art will readily recognize from such discussion, and from the accompanying drawings and claims, that various changes, modifications and variations can be made therein without departing from the spirit and scope of the invention as defined in the following claims.

Claims

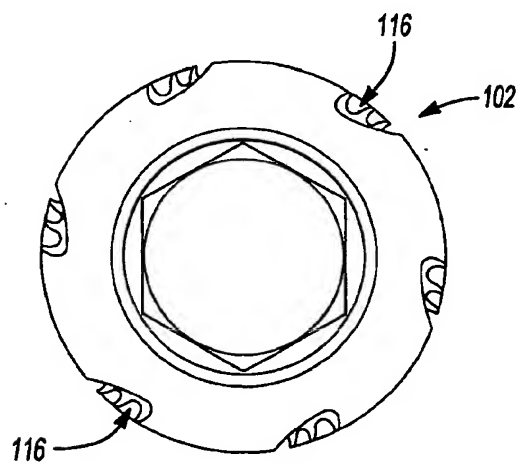
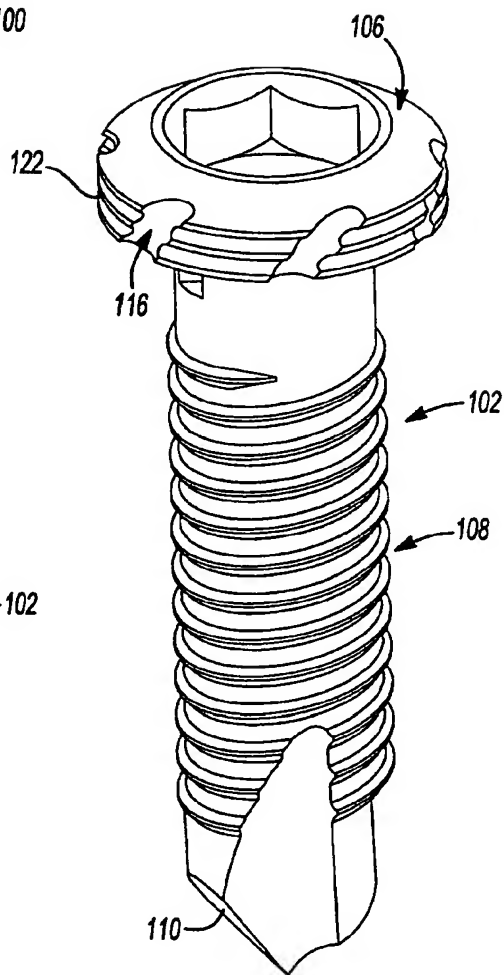
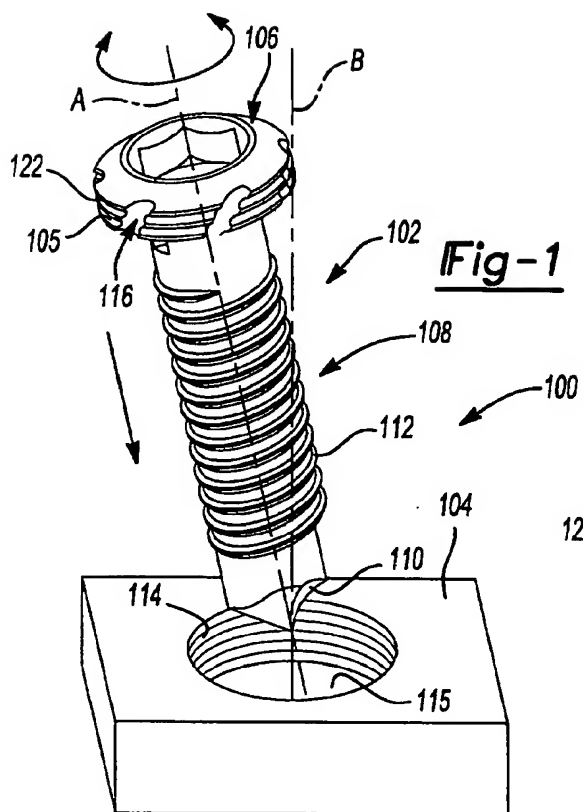
1. A bone fixation assembly comprising:

a bone fastener comprising:

a shaft for engaging a bone, the shaft defining a longitudinal first axis;
a head connected to the shaft; and
a plurality of external thread windings defining an outer surface of the head, the external thread windings circumferentially interrupted by at least one slot defined on the outer surface, the slot inclined at an angle relative to the first axis.

2. The bone fixation assembly of claim 1, further com-

- prising a fixation member defining at least one aperture having a second axis, the aperture comprising internal thread windings for threadably engaging the head of the bone fastener at a variable angle relative to the second axis.
3. The bone fixation assembly of claim 2, wherein the bone fastener and the aperture can be threadably engaged in first and second positions, such that in the first position the first and second axes are substantially coincident, and such that in the second position the first and second axes define a variable angle therebetween.
 4. The bone fixation assembly of claim 3, wherein in the second position the external and internal thread windings are engaged such that at least one external winding engages portions of two internal thread windings.
 5. The bone fixation assembly of claim 3, wherein in the second position the external and internal thread windings are engaged such that at least one internal thread winding engages portions of at least two external thread windings.
 6. The bone fixation assembly of claim 2, wherein the slot is shaped and oriented at an inclination for guiding tissue away from the aperture.
 7. The bone fixation assembly of claim 2, wherein the slot is shaped and oriented for engaging the fastener at an angle relative to the second axis.
 8. The bone fixation assembly of claim 2, wherein the external thread windings are defined on a substantially spherical portion of the outer surface of the head of the fastener.
 9. The bone fixation assembly of claim 8, wherein the internal thread windings are defined on a substantially spherical portion of the aperture.
 10. A bone fixation assembly comprising:
 - a fixation member having a threaded aperture; and
 - a bone fastener having a head and an anchoring portion, the head having circumferentially interrupted external threads such that the head can engage the aperture at an angle by controlled angled-threading.
 11. The bone fixation assembly of claim 10, wherein the head includes a plurality of slots interrupting the external threads and inclined at an angle relative to the external threads for controlling angled-threading between the head and the aperture.
 12. The bone fixation assembly of claim 11, wherein the head and the aperture include spherical surface portions.
 13. A method for securing a bone fastener to a bone fixation member, the method comprising:
 - providing a bone fastener defining a first axis, the bone fastener having a bone anchoring portion and a head having an external thread thereon;
 - providing a bone fixation member defining at least one aperture having an internal thread, the aperture defining a second axis;
 - inserting the bone fastener through the aperture; and
 - securing the head of the bone fastener to the aperture such that the first axis is inclined relative to the second axis.
 14. The method of claim 13, wherein securing the head of the bone fastener to the aperture comprises engaging the external thread at an angle relative to the internal thread.
 15. The method of claim 13, wherein securing the head of the bone fastener to the aperture comprises clearing the aperture from tissue.
 16. The method of claim 15, further comprising guiding tissue away from the aperture.
 17. The method of claim 14, wherein engaging the external thread at an angle relative to the internal thread comprises controlling angled threading between the internal and external threads.
 18. The method of claim 17, wherein controlling angle threading comprises guiding angle threading along a slot, the slot circumferentially interrupting the external thread of the head.
 19. The method of claim 13, wherein securing the head of the bone fastener to the aperture comprises engaging a threaded spherical portion of the aperture with a threaded spherical surface of the head.



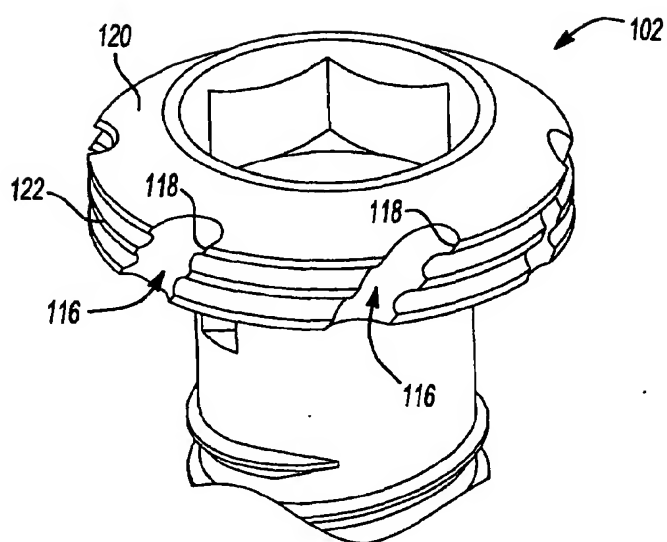


Fig-4

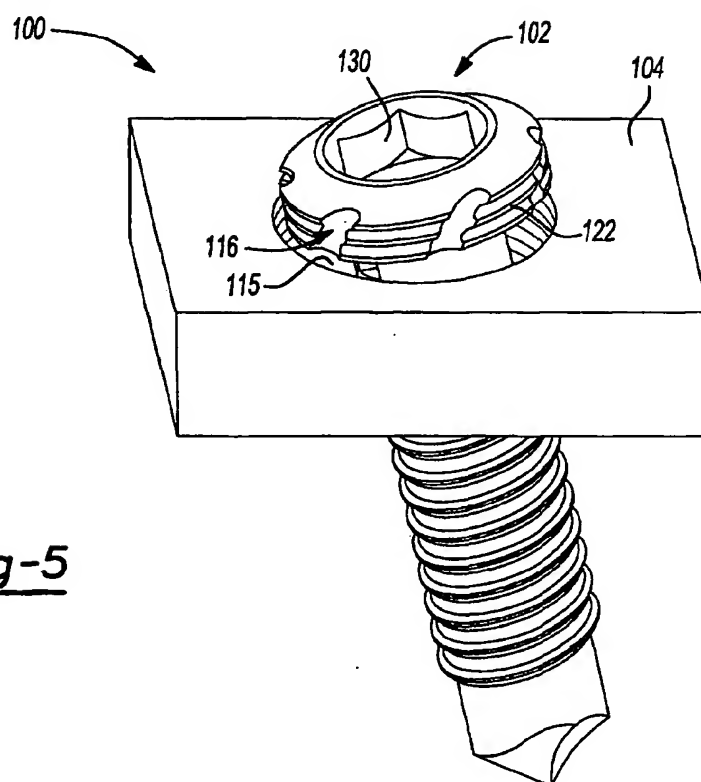
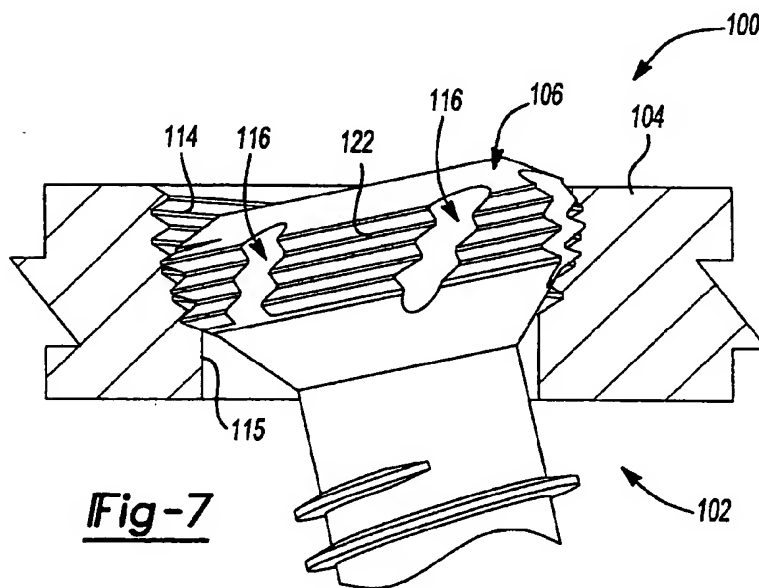
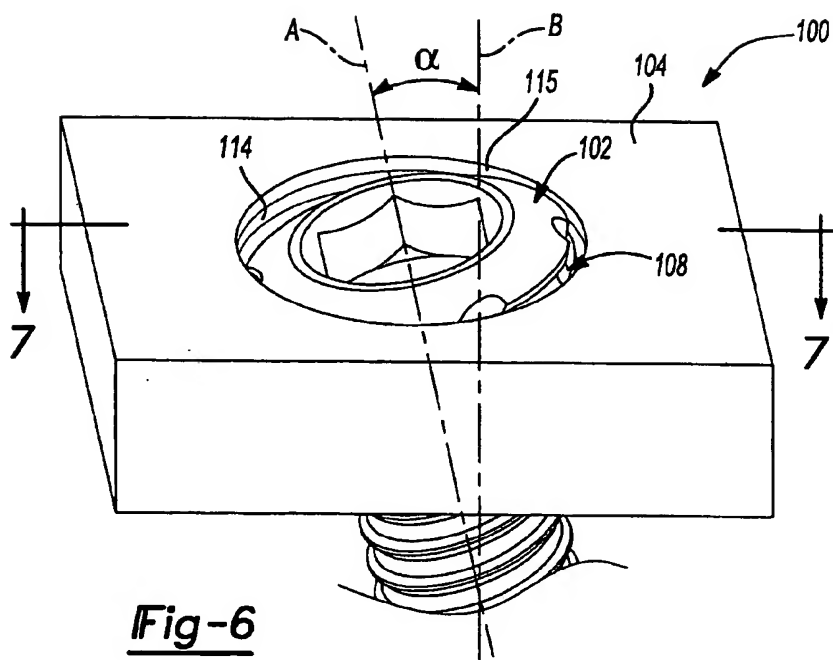


Fig-5



REFERENCES CITED IN THE DESCRIPTION

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